STAT

[redacted]

December 21, 1965

in reply refer to:

U-303

[redacted]

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Gentlemen:

Task Order 04, [redacted]

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In response to your letter of December 10, 1965, a review of the work performed under the subject contract has been made and it has been determined that patent file 65M280 for Laser Color Projection System [redacted] et al has emanated therefrom. A detailed description of this item is enclosed herewith.

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No subcontracts have been let in accordance with the subcontractor provisions of this contract.

It should be noted that this task order provides that the work and reports under this task order are unclassified and, accordingly, is not subject to Article 23, "Filing of Patent Applications," of basic contract number 960. This is a final patent report in accordance with the patent rights provisions of the subject contract.

Very truly yours,

[redacted]

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Enc. 1 copy Description of Invention, 65M280

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Invention Disclosure

DESCRIPTION OF INVENTION

Docket No. 65M280

[Describe(1) each new result obtained by the invention, (2) basic components, ingredients, or steps which are combined to obtain such results, and (3) the operation of the components, etc., which obtain such results. Provide sketches or flow diagrams if helpful in understanding the invention.]

According to the present invention, the automatic contrast control is achieved by illuminating a small portion of the transparency at-a-time, observing with a suitable photocell the amount of light transmitted through this portion of the transparency, and instantaneously adjusting the brightness of light through the medium of a negative feedback circuit. The illumination of the entire transparency, or when desired a portion thereof, is achieved by scanning in an ordinary TV fashion a light diffusing surface, placed behind the transparency, with a spot of light.

It is appropriate to have an area of the scanning spot equal to approximately 1/1000 of the scanned transparency area. The scanning is achieved by means of a rotating twisted mirror polygon drum. Each face of the polygon scans one horizontal line, and thus all 32 faces provide for scanning of 32 horizontal lines. The twisted polygon is shown in Figure 1. The construction of such a polygon is practical only because of a relatively small number of faces.

The entire projection system is depicted diagramatically in Figure 2. The two gas lasers provide the light source for projection. The helium-neon laser emits a red line (6328 Angstroms) and the argon laser emits several spectral lines of which only two are used: a blue line (4880 Angstroms) and a green line (5145 Angstroms). The red beam from the helium-neon laser and the blue and green beams from the argon laser are directed into three light modulators, where the intensity of each beam is either adjusted by an operator to obtain white light by mixing the three colors appropriately, or jointly controlled by a contrast compression circuit to achieve automatic contrast control or dodging during projection. In view of the desired scanning parameters for automatic dodging (32 spots per line, 32 lines per frame, and 60 frames per second), the frequency response of light modulators should be of the order of 120 kilocycles per second. The beam mixer is a simple optical device for combining the three beams from the three light modulators into one white beam, which in turn is directed through a laser-beam lens into a mechanical scanner. The laser-beam lens is a relatively simple lens with a variable effective focal length. Its function is to obtain a desired spot size on a diffuser after the beam passes through the mechanical scanner.

The scanner is a mechano-optical device which provides a sequentially scanned spot of illumination in a raster format on the film. The details of the scanner design are determined from three basic parameters: spot size relative to the film width, scan angle, and frame rate. These three parameters are set, respectively, by considerations of the degree of contrast compression desired in the dodging function, the uniformity of illumination across the film, and the desire for a flicker-free display. The values selected for the three basic parameters are:

Spot diameter	-	1/32 of the film width
Effective scan angle	-	18 degrees
Frame rate	-	60 frames per second

The required number of scan lines per frame is equal to the number of spot diameters per film width scanned (i.e., 32). Because of this moderate requirement, it is possible to design a mechanical scanner with a single rotary element consisting of a single 32-face twisted polygon mirror drum. The mirror faces on the drum are progressively tilted with respect to each other so that during one revolution of the

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FORM 74-5 REV. 10-62

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Invention Disclosure

DESCRIPTION OF INVENTION

Docket No. 65M280

[Describe(1) each new result obtained by the invention, (2) basic components, ingredients, or steps which are combined to obtain such results, and (3) the operation of the components, etc., which obtain such results. Provide sketches or flow diagrams if helpful in understanding the invention.]

Page 2 (Continued)

drum the 32 mirrors will successively scan 32 horizontal lines to form the full scan raster. With this arrangement, the scanning duty cycle for the horizontal scan is 80 percent and for the vertical scan 100 percent. As shown in Figure 1, the axis of the drum is parallel to the plane of the diffuser to be scanned. A nearly parallel beam of light emerging from the laser-beam lens is skew perpendicular to the axis of the drum. The diffuser is a small, high-gain translucent screen. Its inclusion in the laser system is required in order that subsequent lenses are used at full aperture. The extremely high brightness (candles per square foot) of a laser beam is caused by the beam's having a high degree of spatial coherence (collimation). Unfortunately, this extreme collimation is in conflict with the system requirement of projecting the film onto the screen without loss of resolution. The operation of dodging as described requires that a large area relative to the resolution of the transparency be scanned and projected onto the screen. However, to preserve the projected screen resolution, fundamental wave theory requires that the scanning beam so emanate from the film as to fill completely the aperture of the projection lens. The diffuser is used for this purpose. Should the laser be replaced by a source of less spatial coherence, say, an incandescent lamp, the diffuser would not be necessary.

Figure 3 shows the system's optical path from the scanner to the viewing screen, where the optical components are represented schematically. The zoom condenser lens shown in the diagram is necessary in the system to keep the light efficiency constant at various projection magnifications. This lens is mechanically linked with the zoom projection lens. Thus, at different magnifications, the film area illuminated by the zoom condenser lens matches the film area projected by the zoom projection lens. The result of this is constant transmission efficiency, regardless of the magnification. The zoom condenser lens has a constant object size (the diffuser), while the zoom projection lens has a constant image size (the 30 by 30 inch screen). Since the image for the condenser lens and the object for the projection lens is the same area of the film, the two lenses should have the same zoom range. However, the zoom condenser lens is used only for illumination so that a relatively simple lens with its subsequent low resolution of about 10 lines per millimeter can be tolerated. The zoom projection lens, on the other hand, must transfer the desired fine resolution from the film (this may be as much as 200 lines per millimeter for a 1/2 by 1/2-inch field). Such a requirement demands a high-quality lens.

The film gate (Figure 2) is a relatively standard device for holding the film rigidly during projection. In reality, it will be a part of a more complicated set of mechanical equipment including the film reels, mechanism and motors for providing various required film movements.

A standard but appropriately selected photomultiplier is provided for observing the instantaneous illumination of the screen, and generating in turn the electrical signals for the contrast compression circuit. This circuit is essentially a closed-loop negative feedback control circuit which provides means for the automatic compression of dynamic range of the instantaneous light intensity (averaged over one scanning spot) transmitted through the film. The electronic circuitry involved is well known, and, consequently, is not a part of this invention.

The control panel provides various manual controls for operating the laser color projection system. The list of probable

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FORM 74-S REV. 10-62

Sheet 2 of [illegible] Sheets

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Invention Disclosure

Docket No. 65M280

DESCRIPTION OF INVENTION

[Describe(1) each new result obtained by the invention, (2) basic components, ingredients, or steps which are combined to obtain such results, and (3) the operation of the components, etc., which obtain such results. Provide sketches or flow diagrams if helpful in understanding the invention.]

Page 3 (Continued)

1. Three color controls for making **minor** adjustments for obtaining white light from two lasers.
2. Brightness control for adjusting to a desired level the average brightness of the entire screen.
3. Contrast compression control for adjusting the operative range of compression.
4. Scanning spot-size control for adjusting the spot-size on the diffuser to attain uniform illumination over the entire raster frame.
5. Raster frame-rate control for varying the scanning frame rate from a nominal of 60 frames per second.
6. Zoom magnification control for obtaining the desired magnification at the screen.
7. Film-speed control for varying the longitudinal motion of the film ranging from slow speeds for viewing the film to fast speeds for slewing the film in either direction.
8. Joy stick for film translation.
9. Film rotation control for rotation of image within a full circle (360°).
10. Focus control for accurate image focusing on the screen.

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FORM 74-8 REV. 10-62

Sheet 3 of 6 Sheets

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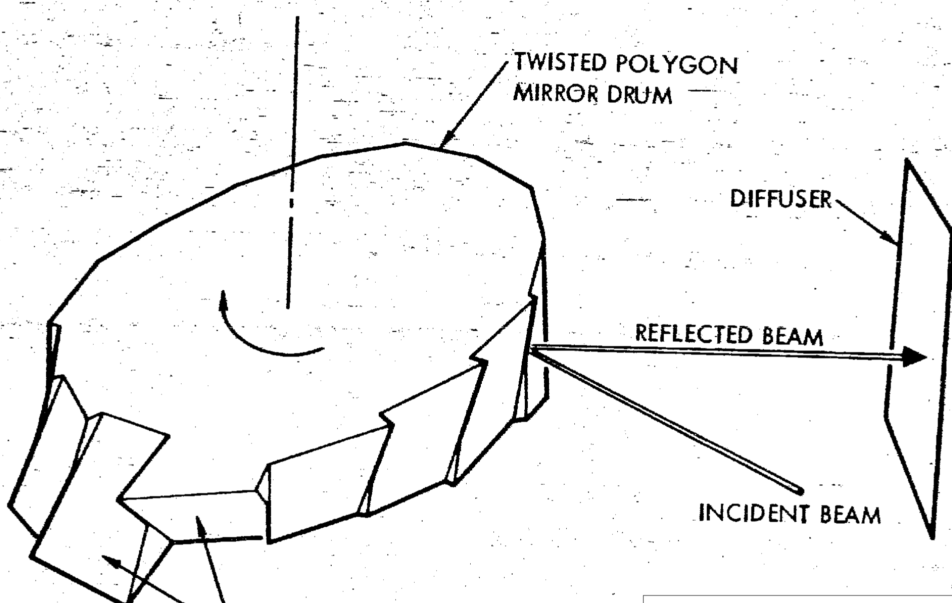

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Figure 1. Mechanical Scanner

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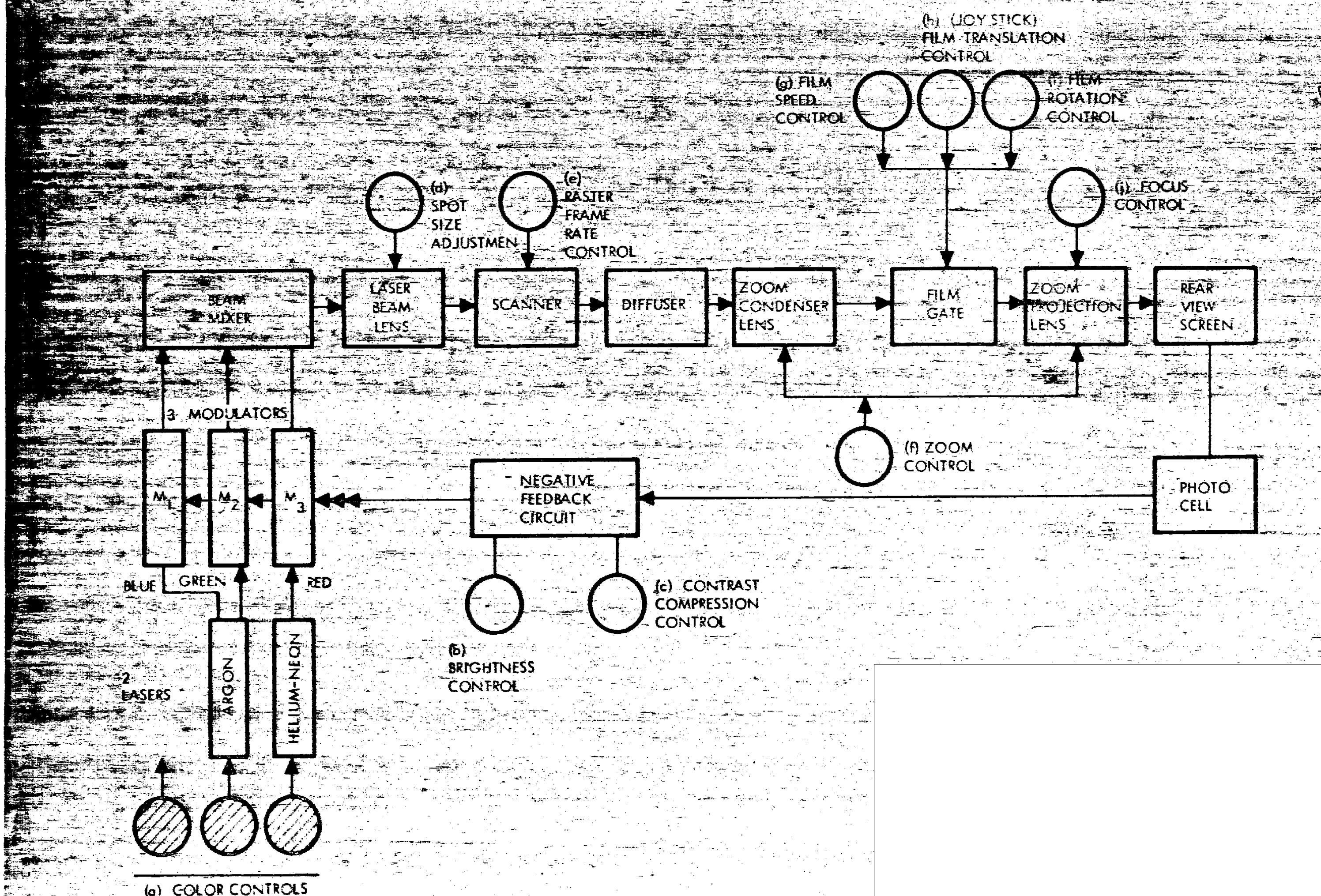

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Figure 2. Laser Film Projection System

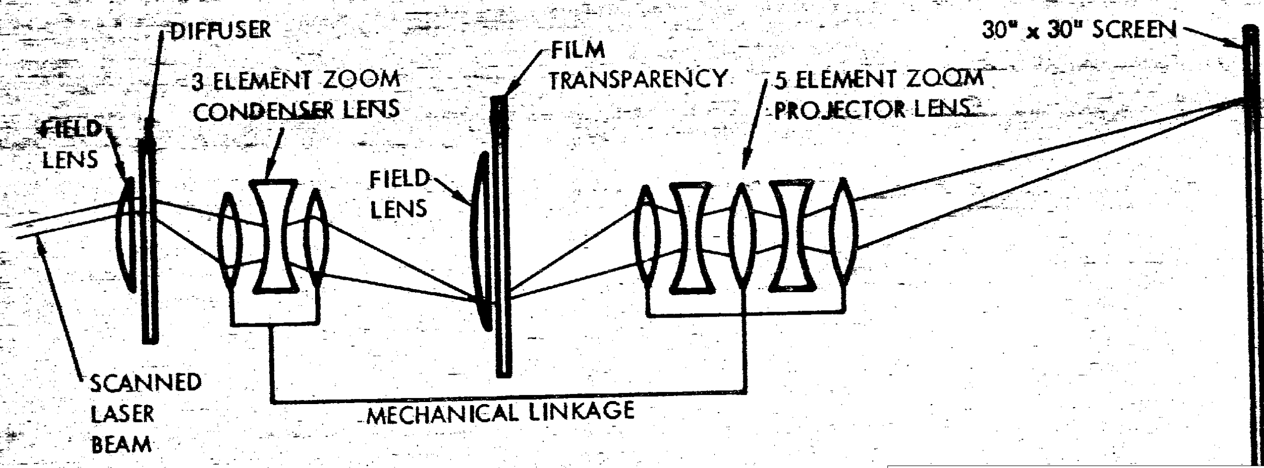

Figure 3. Projector Optical Schematic

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April 8, 1965

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[redacted] Task Order Number 04

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The work under this Task Order has been completed and the Final Report summarizing the results of the study submitted to the Contracting Officer's Technical Representative. A copy of this report is enclosed for your information.

It is noted that this Task Order provides for payment to the Contractor of a performance incentive based on the level of performance. At this time we are preparing an analysis of our performance under the program which will be submitted to you to provide you with additional information to assist in determining the incentive.

We would like to express our appreciation for this opportunity of participating with you in this study.

Very truly yours,

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Enc. 1 copy of Final Report

cc: Post Office Box 9642
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Arlington, Va. 22209

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